

Fluke 233 Remote True-RMS Display Multimeter

A roadtest by Patrick Wijnings for Element 14



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Introduction

As an Electrical Engineering student and hobbyist, I have often heard stories about the quality (and cost) of Fluke instruments. I've always wanted to test one of their multimeters, to see if they meet up to their reputation – and more importantly, if they are worth the extra money when compared with a cheaper multimeter. Thus, I was very excited when I heard I was picked to roadtest the Fluke 233 here on Element 14.

In this review, I will first describe the meter, its specifications, the included items and optional accessories, and give my opinion about them. Then, I will compare the Fluke 233 with a cheaper multimeter, the UNI-T UT60A-cn, and finally conclude whether or not the Fluke is indeed worth the additional costs.



Description of the Fluke 233

Packaging

The multimeter is delivered inside a decently sized box. The meter is secured in a cardboard inlay, and the accessories are in a separate compartment. To protect against scratches, the screen is protected with a plastic film and the meter itself is wrapped in a transparent plastic bag.

Packaging is good enough to protect against transportation damage, but not superfluous, which is good for the environment.

Price and warranty

The multimeter has three years warranty and is sold for approximately 380 EUR (incl. VAT) in Europe, or 300 USD (excl. VAT) in the United States. You can buy it from most large distributors, as [listed](#) on the Fluke website.

Included items and optional accessories

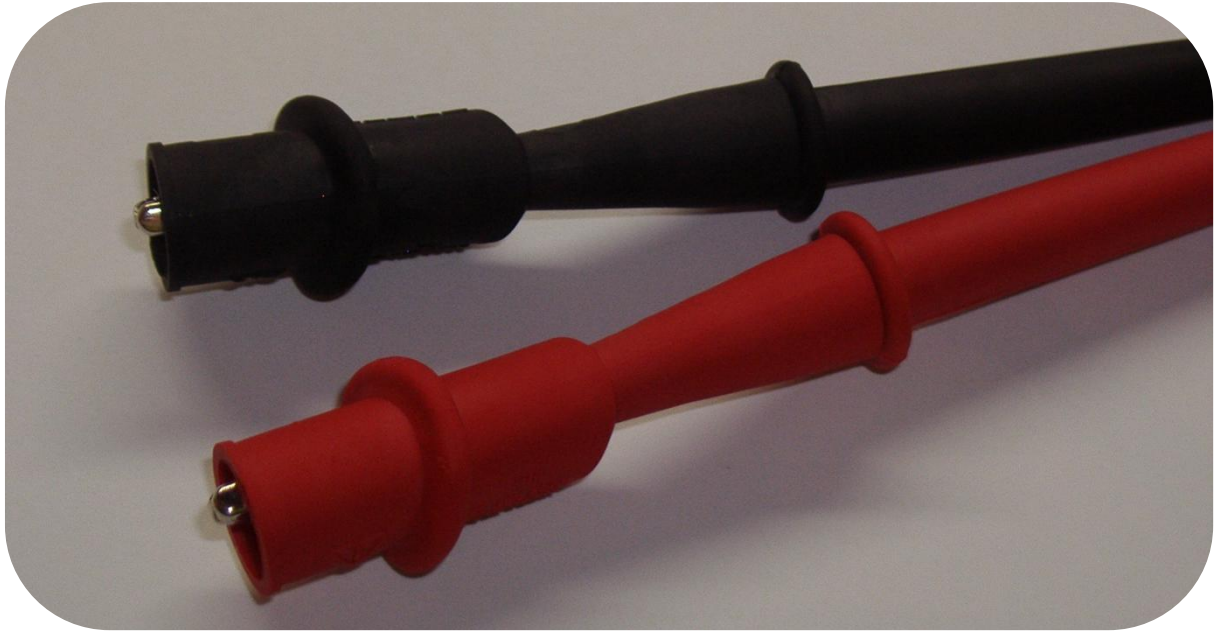
Along with the meter itself, the following items are included in the box:

- A set of test leads (model [TL75](#)) with a cable length of 1.20 m (4 ft). They are rated for CAT III 1000V and CAT IV 600V. They do not have ridges or a soft grip, which makes them feel slightly cheap. I do like the cables however, which are surprisingly flexible. This prevents them from getting in the way. Fluke also sells a set of premium test leads (model [TL71](#)) separately, which have a more comfortable grip. Because the premium test leads are only slightly more expensive than the included leads, it would have been nice if they had been included instead.



- Two crocodile clips (model [AC72](#)) that can be attached to the tips of above probes. These clips are quite heavily insulated and have the same safety ratings as the test leads. They have a jaw opening of about 8 mm (0.3 inch). The crocodile clips are unsuitable for precise measurements because the insulation gets in the way. For fine measurements, Fluke sells additional probes such as the [TL223](#). Although it would have been nice if these had been included, it is not a problem because you can also use a length of wire attached to the crocodile clips instead.





- A temperature probe (model [80BK-A](#)). It can be plugged into the multimeter to perform temperature measurements from -40 to 260°C (-40 to 500°F). The wire is around 1 m (3.2 ft) long and very stiff. I get the feeling that, if you use it too often, it will break of metal fatigue. Fluke also sells other thermocouples with bead, lance or pipe clamp probes.



- Various documentation and manuals:
 - A sheet that describes how to prepare the multimeter for first use.

- A “Statement of Calibration Practices” that states the meter is calibrated according to ISO-9001 procedures and that a calibration certificate is obtainable at additional cost.
- A notice that says the instrument should not be disposed in domestic household waste.
- A registration form that can be returned by mail. No postage is required (worldwide!). Registering can also be done on-line.
- A “Getting Started Manual” in 18 different languages.
- A CD-ROM with product manuals and other product-related information. If you lose the CD-ROM, the manuals can also be obtained from the [Fluke website](#). Most documentation is available in multiple languages.

The documentation is very clearly written, unlike those Chinese products with badly translated manuals. I did not discover any spelling errors.

- Five AA batteries, already installed in the meter. Although the documentation states that they are protected with plastic strips for transportation, the strips had already been removed and the three batteries in the base station were already empty when I received the package. Maybe my sample has been used as a demo model before? Nevertheless, it is nice to see that Fluke did not economize on batteries because the batteries are of Duracell brand.



- Fluke has several other accessories, such as carrying cases, current clamps, a pressure vacuum module and a “ToolPak” meter hanging kit ([TPAK](#)). This kit can be attached to the back of the multimeter and then used to suspend the meter using a magnet or a string loop from e.g. a pipe. None of these is included with the multimeter.

The meter itself



Measurement modes

The Fluke 233 has quite a few measurement modes:

- Voltage: up to 1000 V. The meter can measure both DC and AC voltages, and is also equipped with “True RMS”. True RMS means that the effective AC voltage is not only correctly displayed for sine waves, but also for other waveforms, although there are some limitations concerning the crest factor of these waveforms.
- Current: up to 10 A, both DC and AC. The current mode is also equipped with True RMS. Currents between 10 and 20 A can also be measured, but measurements must not take longer than 30 seconds, and accuracy is not specified for this range.
- Resistance: up to 40 MΩ. Especially handy if you cannot remember those colour codes.
- Temperature: from -40 to 400°C (-40 to 752°F), although the thermocouple must also support these temperatures. As mentioned above, the included probe can only handle up to 260°C (500°F).
- Capacitance: up to 9999 μF. Especially handy if you cannot decipher those markings.
- Diode tester. For measuring the direction and bias voltage of diodes or transistors.
- Frequency: up to 50 kHz for voltage and up to 5 kHz for current.
- Continuity beeper: indispensable when debugging hand-soldered circuits for shorts. The display module beeps when a short circuit between the probes is detected.

You can find detailed information about the available ranges and accuracies in the [manual](#). The specified accuracies are valid for one year after calibration.

The meter is auto-ranging, which means that the display scale will automatically be adjusted. By pressing a button, it can also be overridden with a manual range, which is handy if a measurement is on the border of two display scales. Additional measurement features include a hold function, which freezes the display, and a min-max measurement, which measures minimum, maximum and average values over a longer period. This last feature is useful when testing a power supply, for example.

The base station: build quality and first impressions

Like most Fluke instruments, the meter is made of black plastic with a yellow, hard rubber covering. The housing is solid enough to survive a drop off the table. The covering has a fine texture that is not very sensitive for fingerprints, and provides a nice grip of the meter. However, the meter is too heavy to be held in your hand comfortably with its weight of 600 g (1.3 lb), especially for a longer time, although the removable display module and the optional ToolPak accessory partly compensate for this. A large part of the weight is caused by the five AA batteries. I would have preferred two 9V batteries, which weigh a bit less than the AA batteries.

The rotary knob needs a fair amount of force to turn. The meter does not have a separate power button, which I do not like: when you want to turn off the meter, you have to turn back the knob every time. Because this is clumsy, you will probably leave the meter on between measurements, draining the batteries more than needed. It will also increase the wear on the rotary knob, which might become weak over time and eventually malfunction, which is how I lost a multimeter of another brand. The meter also has a yellow "Shift" key, which can be used to switch between different but similar modes, such as resistance measuring and continuity testing. The state of the shift key is forgotten if the rotary knob is turned.

There are three connectors for the probes: one for high impedance (voltage) measurements, one for low impedance (current) measurements and one ground connector. This means both low and high current measurements use the same connector, unlike a lot of other multimeters. The connection with the probe plugs is quite firm: they will not fall out accidentally.

The meter does not make any audible noise, except of course for the continuity beeper, which also beeps if you press a button. The beeper is located in the removable display module.

The Fluke 233 takes about three seconds to start up; the measurements itself take a second or two, even with auto-range enabled. The meter feels quick enough to not be inconvenient.

The back of the multimeter houses a stand and the battery compartment of the base station. You can open the battery compartment by turning the large screw half a turn. This makes replacing the batteries very easy. I am less satisfied with the stand, however. It is quite thin and it *will* break if you pull it too far.



When you look at the top of the multimeter, you can see the attachment point for the ToolPak and two probe holders. The probe holders can be used to store the test probes when they are not in use.



The display module

The most eye-catching feature of this meter is the removable display module. Fluke has a [video](#) on its website demonstrating its use. It can be removed from the base station by pressing two buttons on the side. These buttons make sure the display module does not fall out accidentally. When the display module is attached to the base station, communication is done using an infrared port: the display module is electrically insulated from the base station. When it is removed, communication seamlessly switches over to a 2.4 GHz RF link. This switch is really well done: there are no noticeable delays or glitches when removing or reattaching the display module. You can also turn the meter on when the display module is detached, although you must attach it at least once after replacing the batteries.

Of course, this means there are always some standby circuits active in the display module: it cannot be powered off completely, which might reduce battery life a bit. Battery life is rated 400 hours in the manual. I wonder if this time is achieved in practice, however, partly because three of the batteries were already empty when I received the meter.

The removable display module is especially handy when you need to measure a dangerous machine. With this meter, you can install the base station, take the display module with you to the control panel and turn the machine on, without the need of being near it.

One of the pictures on the Fluke website seems to suggest that the meter can also be used in climate test chambers: the base station inside and the display module outside, so you don't have to peek through the possibly condensed window. Keep in mind, however, that the base station is not rated for high humidity in combination with high temperature. This limits the suitability for this application somewhat.





The display module has four buttons: “Hold”, “Min-max” and “Range” for enabling the special measurement modes described earlier, and one button for the backlight. The backlight is useful when measuring in dark environments, for example when repairing a power failure. You can see the difference between the display with and without backlight in the picture below.



At the back of the display module, you can see the IR port and the battery compartment. You can simply slide off the lid of the compartment, which makes replacing the batteries of the display module even easier than replacing the batteries of the base station. The lid also houses a strong magnet, which allows you to attach the display module to metal surfaces.

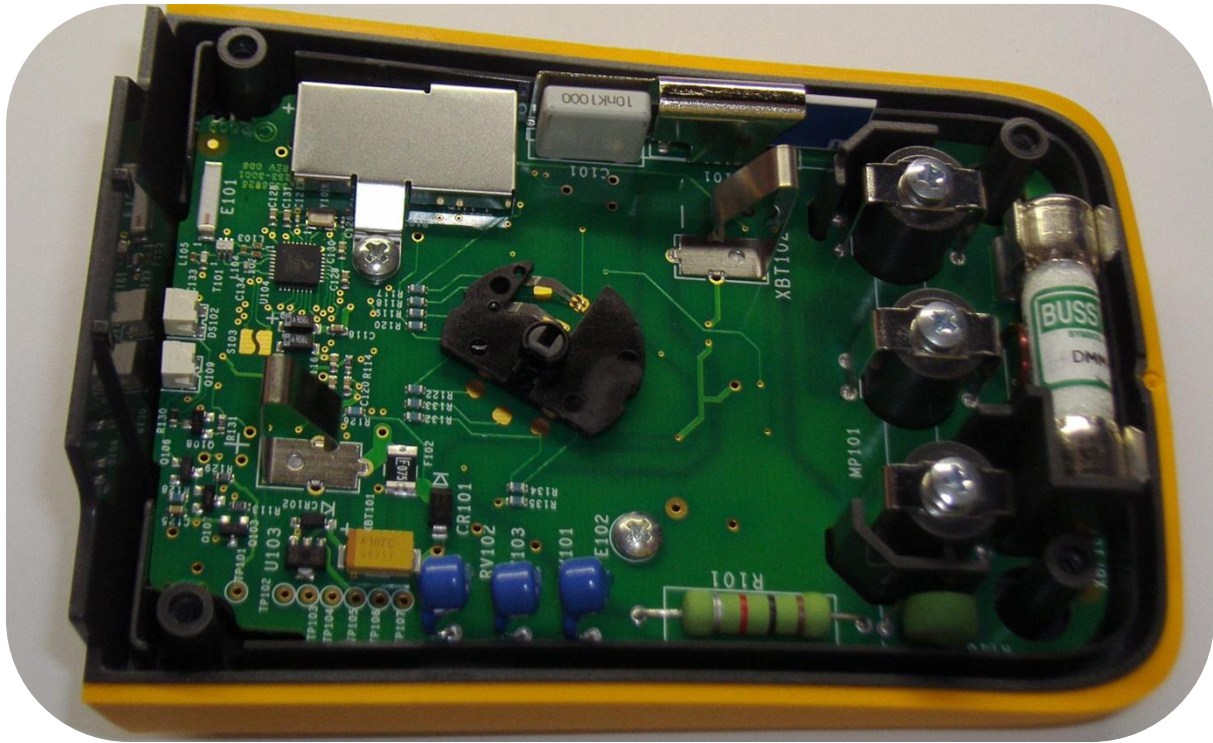


According to the specifications, maximum range is about 10 m (32.8 ft) in open air. Inside, the display module lost signal at a distance of about 6 m (20 ft) and with two thick concrete floors between the base station and the display module, so range is satisfactory.

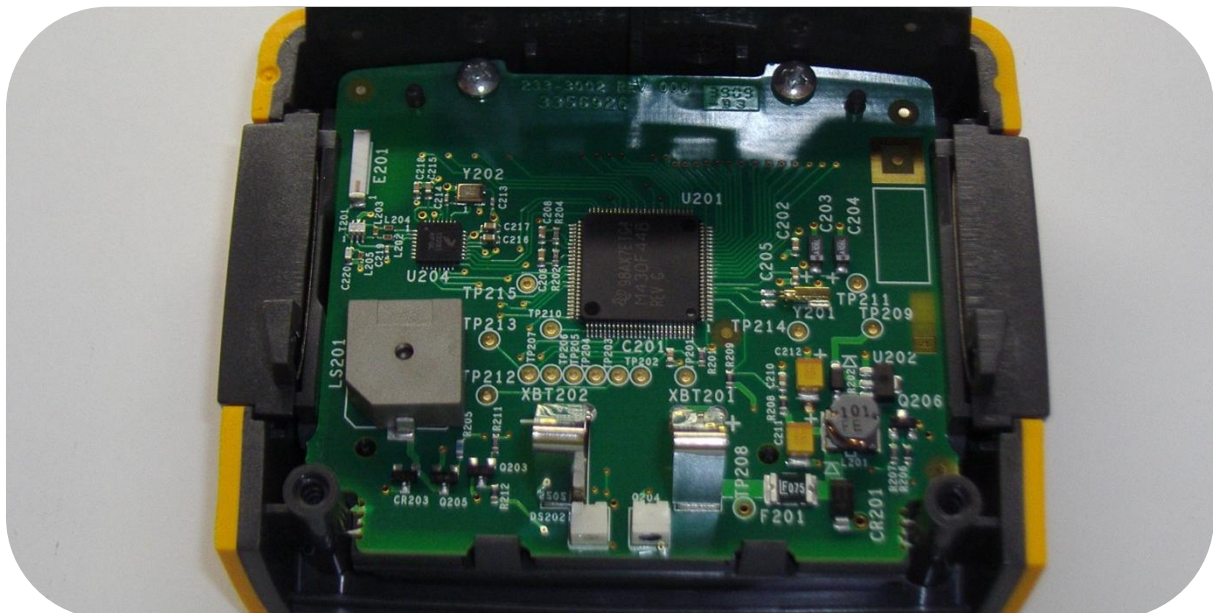
The meter disassembled: safety features

The most important feature of a multimeter is, of course, its safety. With a voltage range of 1000 V and a current range of 10 A, measurements can be quite dangerous. And what if the operator makes an error, and the meter is accidentally exposed to an even higher voltage or current? A good multimeter has one or more fuses inside to prevent damage to the meter, and a well-designed circuit layout so no arcing will occur (up to a certain extent, of course). But, before I open up the Fluke 233, let us look at the outside. Fluke has included a warning symbol on the display that lights if a dangerous voltage is detected. The base station is also equipped with a warning light that has the same function, so you are still warned if the display module is removed. When you turn on the meter, the light blinks for a second, so you can verify it is still working. Fluke has thought this out extremely well.

Now, let's remove the cover of the base station, which is held together by four crosshead screws. Inside, you can see a big, fat F11 fuse, which is rated for 1000 V and has an interrupt rating of 17 kA. Because the meter has only one low impedance connector, only one fuse is necessary. Fluke sells replacement fuses for 9.00 USD in their [online shop](#). Although the fuse is quite expensive, you will only need to replace it if you make an error while measuring.



Low and high voltage parts are neatly separated, and there is enough space between the high voltage PCB traces. You can also see the RF transceiver near the shielded box (U104; Freescale MC13201), and a lot of test pins, which are probably used for calibration. There are a separate IR transmitter and receiver, which shows that the communication link between display module and base station is bidirectional. The shielded box contains several discrete components and an unknown IC (U101; LTFLK2 387248). According to a document on the Fluke website, the heart of the multimeter is a Texas Instruments microcontroller (U102; MSP430F449, 60 kB Flash, 2048 B RAM). Calibration data is stored together with the operating code in the Flash memory, so it is not easy to calibrate the meter yourself. The main processor is probably located on the back side of the PCB. Further disassembling of the meter takes a lot of effort because the rotary knob must be removed, so let us look at the inside of the display module instead.



You can see another RF transceiver (U204), IR transmitter and receiver, the buzzer (LS201) and the display microcontroller (U201; TI MSP430F448, 48 kB Flash, 2048 B RAM).

Recapitulating, the inside of the multimeter is cleanly designed and the big fuse combined with the large spacing between the high voltage traces provide enough safety, even if the maximum voltage or current ratings are exceeded.

Comparison with the UNI-T UT60A-cn

Now that we have met the Fluke 233, let's introduce its competitor: the UNI-T (Uni-Trend) UT60A-cn.

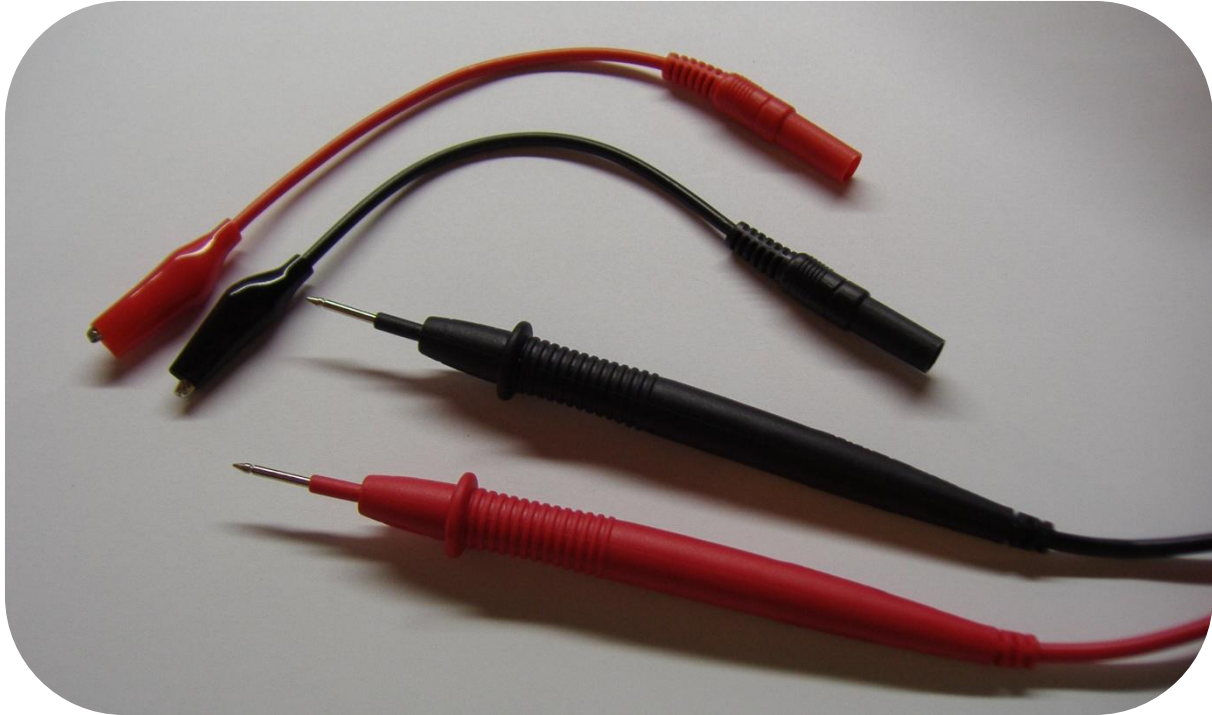


Price

The UNI-T UT60A-cn is sold for around 60 USD (excl. VAT). I bought mine at [Sparkfun Electronics](#). The price is also the most notable feature of this multimeter: it is five times (!) as cheap as the Fluke multimeter.

Included items

Like the Fluke 233, the UNI-T includes two probes, a set of crocodile clips and an English-only operating manual. The probes have ridges and are of better quality than the Fluke ones, although the cable is a little less flexible. The crocodile clips are only usable for low power applications because they are not insulated very well. Because the cables of the crocodile clips are only 10 cm (4 inch), the usability of them is limited. I like the crocodile clips of the Fluke multimeter better. The meter needs one 9 V battery, which is not included.



A luxury version of the UT60A-cn called the UT60A is also available. It is sometimes rebranded as Voltcraft VC820 and includes a RS232 link cable, computer software and a battery.

All in all, the UNI-T clearly wins in price, and included items do not differ much.

Measurements

The UNI-T can roughly do the same measurements as the Fluke 233. The differences are:

- The Fluke can directly do temperature measurements, the UNI-T cannot. However, with a separate temperature sensor, the UNI-T can do temperature measurements too, although you would need to convert from resistance to temperature manually.
- The UNI-T can do duty cycle measurements, the Fluke cannot. Practical use is limited, however, because the manual states that accuracy is not guaranteed.
- The capacitance range is different: the UNI-T resolution is 10 pF and the maximum range is 100 μ F. The Fluke resolution is worse with its 1 nF, but the maximum range of 9999 μ F is better.
- The UNI-T can only do continuous current measurements when the current is below 400 mA. For higher current measurements, the probe must be plugged into a special connector, and a measurement may only be done for 10 seconds every 15 minutes. The Fluke can do continuous current measurements over its full range.
- The Fluke has a Min-Max measurement mode, the UNI-T does not. However, the UNI-T has a Relative (Δ) mode, which sets the zero value to the currently measured value. This mode saves some calculations when you are measuring differences. The Fluke does not have this mode.
- The auto-range function of the UNI-T is quite slow when compared to the Fluke. It takes several seconds before the meter has selected the correct display scale.

In my opinion, the measurement modes of the Fluke are slightly more useful. More information about the supported ranges and accuracies of the UNI-T can be found on the [Uni-Trend website](#). Like the Fluke, the UNI-T is calibrated according to ISO-9001 procedures. Also, it should be noted that I cannot validate the given specifications, not for the UNI-T nor for the Fluke because I do not have the test equipment needed for that.

Further, the Fluke is more than twice as accurate for *all* measurement modes that are supported by both instruments. However, how useful is this extra accuracy in practice? For some uses, such as calibration of machines or laboratory work, it is. However, the more accurate bench-top multimeters are preferable in these situations. For building or debugging circuits, an estimate measurement or continuity test will often suffice; in situations where the exact value is important, an oscilloscope is more useful because they can also capture the complete waveforms, even at high frequencies. Thus, because portable multimeters are made for all-round usage, the accuracies of both meters are good enough in my opinion, although the Fluke absolutely performs better.

Build quality

The first thing that attracts attention is the difference in weight: the Fluke weighs twice as much as the UNI-T, and it is also a bit larger. The texture of the UNI-T is not as nice as that of the Fluke, which certainly makes the UNI-T feel cheaper. The rotary knob of the UNI-T rotates more smoothly, however, and the UNI-T does have a separate power button. Also, the stand of the UNI-T is thicker than that of the Fluke, although it will easily break off too if you pull it too far.

As mentioned before, the UNI-T has a fourth connector for high current measurements. This means the probes must be re-plugged more often, which is more error-prone. You do not need much force to pull the probe plugs out, contrary to the Fluke. However, they will not fall out accidentally, which is why I like them more than the connectors of the Fluke.

Another eye-catching difference is the clarity of the display. Even without backlight, the Fluke display is a lot more readable than the UNI-T display, as you can see in the picture below, where I tried to keep incidence of ambient light the same for both meters.



Summarizing, the build quality of the Fluke is better and it feels much more solid in general, although I like some parts of the UNI-T better, such as its power button and connectors.

Safety and interior build quality

The last comparison I will make between both meters is in the field of safety. On the outside, there is only one difference: the UNI-T does not have a warning light like the Fluke. Both meters are well insulated. So, let's open up the UNI-T too and compare their insides. In the picture below, you can see the fully disassembled UNI-T. Notice the shielding sheet, which is actually tinfoil coated with plastic. To be honest, I don't know the purpose of shielding the whole PCB. A small shielded box with all the sensitive components inside, like the one inside the Fluke, seems like a better idea to me.



But the differences don't stop there. Just look at the soldering quality: some components in the UNI-T are so crookedly soldered that it almost seems like bad handwork. Also, the microprocessor is of unknown make, hidden in a black blob in the middle of the PCB. Additionally, the PCB layout of the Fluke is much more compact, and has a clearer separation between the low and high voltage parts.

On the other side of the PCB, which I did not photograph, are two standard glass fuses, one for each low impedance connector, and a small potentiometer, which can probably be used to calibrate the meter.

Obviously, this is where the Fluke shows its added value. The mediocre build quality of the UNI-T might cause serious damage if something were to go wrong during a high voltage or current measurement.

Conclusion

Now that the Fluke 233 has been compared with a budget multimeter, it is time for my final verdict.

Build quality of the Fluke 233 is very good, it offers extensive functionality and its insides are constructed safely. It does indeed live up to its reputation. Moreover, Fluke offers excellent support, spare parts and accessories, and reparation and calibration services. The main pro of the UNI-T UT60A-cn is its price, combined with the fact that it performs well enough for low voltage and current applications.

For professional purposes, I would recommend the Fluke 233 over the UNI-T, because of the superior build quality (and thus reliability) and the many support options: I could not find any premium support options on the Uni-Trend website. I think professionals will gladly pay the premium price in exchange for the certainty of good support. Also, the removable display module makes certain jobs easier and a lot less dangerous.

For personal or hobbyist purposes, however, the story is different. Premium support and calibration services are too expensive for personal use. Also, the superior build quality of the Fluke 233 does not warrant its high price: even if the Fluke will last five times longer than UNI-T, buying five UNI-T meters is still more economical. If you are specialized in high power applications, I would absolutely recommend the Fluke 233 over the UT60A, because of the questionable safety and the lack of continuous high current measurements of the latter. If you mostly use your multimeter for building or debugging low or medium power systems, however, I would recommend a cheap meter over the Fluke, unless you absolutely want to go for quality, need the removable display module, or simply have money to burn. With the money you save, you can buy a low-cost oscilloscope, which adds much more value than the Fluke 233 for these applications.

Feedback

I hope this review has been useful to you. If you have any questions or feedback about this review, or would like more information about a specific feature of the multimeter, please post a message, and I will try to answer them. Finally, I would like to thank Alistair Winning and Fluke for giving me the opportunity to test this multimeter.